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NOVEMBER 1950

OFFICIAL
PUBLICATION

NATIONAL LUBRICATING GREASE INST
NLGI

HOWARD
COOPER

. . . N.L.G.I.
1951 President

(See Page 4)

some Glycerides are *unusual*, too

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In This Issue

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HOWARD COOPER IS NEW N.L.G.I. PRESIDENT

Newly elected president of the NLGI is Howard Cooper, whose picture appears on this month's cover. His election was announced at the annual meeting held October 30-November 1 at Chicago. Mr. Cooper succeeds Mr. A. J. Daniel, the retiring president.

Mr. Cooper was elected to the board of directors in October, 1945; his active and constant interest in NLGI affairs was recognized by his election to the vice presidency in 1950 and the presidency for 1951. During 1950 he served the Institute as chairman of the program committee.

A petroleum industry pioneer, he began his career a year following his graduation from the Armour Institute of Technology (now known as the Illinois Institute of Technology). With a B.S. degree in mechanical engineering, he joined the Texas Company in Chicago as lubrication engineer.

Since 1923 Mr. Cooper has been associated with Sinclair Refining Company as lubrication engineer, assistant manager of lubricating sales, chief lubrication engineer and, currently, as manager of technical service.

During World War I, he served for a year in the U. S. Army Air Service, first as a civilian and later as a first lieutenant; in World War II was section chief in the Marketing Division of the Petroleum Administration for War for three and a half years.

He is a member of the A.S.M.E., S.A.E., A.S.T.M. and the A.S.L.E.

President's page

by Howard Cooper, President, N.L.G.I.

Thanksgiving and Dedication

When the early New England settlers gathered for the first Day of Thanksgiving, their hearts were filled with gratitude for God's protection and provision, for the guidance that had led them safely through troublous days, for the escape from tyranny, and for the welding together that some day was to culminate in the formation of the greatest republic of free men on earth.

At the same time, these contemplations on their blessings were accompanied by visions into the future—a looking-forward to a strengthening of their attained position, and toward increased prosperity and greatness. With thanksgiving the pilgrim fathers surveyed the past; while with continued determination they dedicated themselves anew to unfaltering effort toward progress in the days ahead.

There is perceived, in all reverence, an analogy in the birth and growth of the National Lubricating Grease Institute, which it is timely to present since the administrative year of the Institute begins as the national Thanksgiving Day approaches.

Like the pilgrim fathers, the incoming officers of the N.L.G.I. have reason to give thanks. They are grateful for the courage and vision of those three stalwarts who conceived the worthy principles and laid the sound foundation on which the Institute has been built, to emerge as an association recognized for leadership. They give thanks for stouthearted predecessors who would not waiver from their purpose and who brought the organization safely through difficult periods. Humble praise is due all those whose loyalty and efforts through 18 years have never shown a weakening, but always a constant strength. It is because of such capable guidance and administration that the Institute can report an all-time high in membership, and a record attendance and interest at the last Annual Meeting.

So, the newly elected officers give thanks for the inspiration of past accomplishments and for the success of previous years. Now, they look forward into the future earnestly and determinedly, dedicating their efforts to nurturing continued healthy growth of the Institute and to strengthening its position of leadership.


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Relationship between PUMPABILITY AND VISCOSITY OF Lubricating Greases

by J. W. AMNER
J. F. T. BLOTT
S. DAWTREY
"Shell" Central Laboratories, London

SUMMARY

The subject is introduced by a brief discussion of the essential requirements to enable the flow of non-Newtonian systems to be predicted.

Methods of measuring and expressing viscosity characteristics are considered and data are presented to illustrate the characteristics of different types of greases.

Experimental evidence is given which demonstrates the validity of applying viscosity data to the prediction of the flow of grease in pipes. The influence of the type of grease on its pumpability under a variety of practical conditions is discussed.

1. INTRODUCTION

The viscosity coefficient of a material under conditions of laminar flow is defined as the ratio between the shearing stress acting on an element of volume within the material and the corresponding rate of shear strain. When the value of this ratio remains constant with variations in the shearing stress, the material is described as showing Newtonian flow while if the ratio changes with the shearing stress, the material is described as showing non-Newtonian flow. In non-Newtonian flow the value of the ratio may also depend on the amount of strain i.e. the duration of shearing, and the material is then described as showing "strain thixotropy."

For the flow of any type of material in a tube of circular cross section, the shearing stress at the wall of the tube is given by $F = \frac{PD}{4L}$, where P = pressure drop; L = length of tube; D = diameter of tube. With Newtonian materials, the corresponding rate of shear strain at the wall of the tube is given as indicated by Poiseuille's equation, by $S = \frac{32Q}{\pi D^3}$, where Q = volume of flow in unit time.

Since the value of the ratio of the shearing stress (F) to the rate of shear strain (S) for a Newtonian material is independent of the magnitude of the shearing stress, a straight line passing through the origin will be obtained when values of $F = \frac{PD}{4L}$ are plotted against the corresponding values of $S = \frac{32Q}{\pi D^3}$ derived from measurements in tubes of any dimensions with a given Newtonian material. By a rigorous mathematical analysis, Mooney[1] showed that, provided no slip occurs at the wall of the tube and when strain thixotropy and pronounced elastic effects are absent, the corresponding relationship between $\frac{PD}{4L}$ and $\frac{32Q}{\pi D^3}$ for non-Newtonian materials will be a unique curve which will apply to the flow of the given material through tubes of any dimensions. With these non-Newtonian materials, however, the value of $\frac{32Q}{\pi D^3}$ will not be the true rate of strain at the wall of the tube and is referred to as the "apparent rate of strain."

Experience with a large number of experimental and commercial lubricating greases has shown that, in most cases, these materials exhibit little strain thixotropy, when tested after working with 60 double strokes in the conventional grease worker, and no evidence of slip at the wall of the tube is obtained at apparent rates of strain within the range which is normally of interest in the problem of pumping[2]. A knowledge of the unique curve relating $\frac{PD}{4L}$ and $\frac{32Q}{\pi D^3}$

for such non-Newtonian materials is, therefore, in theory sufficient to enable flow to be predicted under practical conditions in pipes of any dimensions. This curve may be established directly from laboratory measurements in capillary tube viscometers or may be derived from measurements in other types of viscometers. The flow conditions in the viscometer may usually be arranged to cover the range of values of $\frac{PD}{4L}$ which occur in the practical applications concerned.

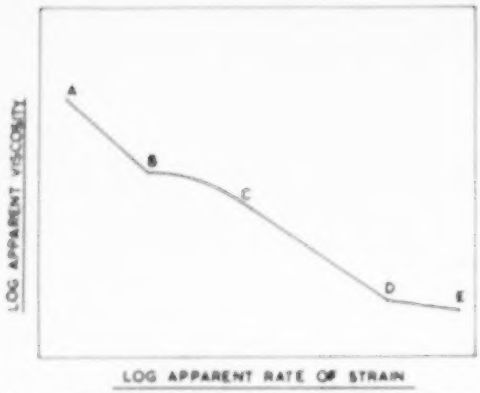


FIG. I. TYPICAL APPARENT VISCOSITY - APPARENT RATE OF STRAIN RELATIONSHIP FOR LUBRICATING GREASES

2. METHODS OF MEASURING VISCOSITY CHARACTERISTICS

Any method of measuring corresponding values of shearing stress and rate of strain can be used to determine the flow characteristics of grease. Viscometers employed for this purpose are, in general, of two types. In the first type, a certain rate of strain is imposed on the material and the shearing stress which is generated is measured, while, in the second type, a certain shearing stress is imposed and the resulting rate of strain is measured. In either case the shearing stress/rate of strain relationship should be determined over a range which is sufficient to cover the variety of conditions met in practice and a number of measurements at different stresses or rates of strain is required to allow the unique curve between $\frac{PD}{4L}$ and $\frac{32Q}{\pi D^3}$ to be accurately constructed.

An example of the first type of viscometer is the S.O.D. pressure viscometer[4]. Curves obtained from measurements with this instrument have been given in various scientific and technical journals. The data presented in this paper were derived from measurements in a viscometer of the second type and known as the "plunger" viscometer, designed and made at "Shell" Central Laboratories, London, in 1942. Details of the theory, construction and operation of the instrument have been given elsewhere[1].

Briefly, the plunger viscometer consists of a solid cylindrical plunger sliding concentrically within a cylindrical tube with a small clearance (0.005" to 0.010" in different instruments) between the plunger and the tube. The tube, closed by a screw plug at the lower end, is partly filled with grease and the plunger is forced into the tube under an applied load, thus causing grease to flow up the annular space between plunger and tube. From the known dimensions of the apparatus, the load applied to the plunger and the resulting rate of flow, the shearing stress and the corresponding apparent rate of strain at the wall of the annulus may be calculated. Rates of strain ranging from about 0.01 to 3,000 sec^{-1} and shearing stresses from about 100 to 100,000 $dyne/cm^2$ can be covered and sufficient readings can be taken with one filling of the viscometer to provide data for the construction of a curve giving the shearing stress/apparent rate of strain relationship for the grease over the range required.

It should be pointed out that the apparent rate of strain calculated for a given shearing stress at the wall of the annulus in the plunger viscometer will not be strictly the same as that corresponding to the same shearing stress acting at the wall of a tube of circular cross section. It can be shown, however, that for practical purposes the difference between these two values is small enough to be ignored. The shearing stress at the wall of the annulus and the corresponding calculated apparent rate of strain may be recorded as values of $\frac{PD}{4L}$ and $\frac{32Q}{\pi D^3}$ which may be applied to the flow of the material through tubes of circular cross section and of any dimensions.

Although the curve relating $\frac{PD}{4L}$ and $\frac{32Q}{\pi D^3}$ expresses laboratory measurements in the form in which they can be applied most directly to practical flow problems, it is customary to present experimental viscosity data as the relationship between the logarithm of the apparent viscosity coefficient and the logarithm of the apparent rate of strain. This method has the merit of emphasizing differences between different types of greases and enables the wide range of experimental values to be accommodated in one graph.

Experimental data are usually given in c.g.s. units. In applying these data to industrial problems, it is convenient to give expressions for shearing stress and rate of strain in a form which allows the use of the units commonly employed in industry. These expressions are as follows:

$$\text{Shearing stress, F, in dyne/cm}^2 = 1440 \frac{PD}{L} \qquad (1)$$

$$\text{Apparent rate of strain, S, in sec}^{-1} = 0.315 \frac{Q}{D^3} \qquad (2)$$

$$\text{Apparent viscosity coefficient, } \eta \text{, in poises} = \frac{F}{S} \qquad (3)$$

where: P = pressure drop, in p.s.i.;
D = diameter of pipe, in inches;
L = length of pipe, in feet;
Q = flow rate, in oz/min.

In equation (2), where a conversion from weight to volume is involved, the factor 0.315 incorporates an average value of 0.93 for the bulk density of grease.

3. VISCOSITY CHARACTERISTICS OF DIFFERENT TYPES OF GREASES

Data obtained in these laboratories have shown that, provided a sufficiently wide range of rates of strain is covered, most greases give a curve of the same general form as that illustrated diagrammatically in Fig. 1.

The curve consists of three linear sections AB, CD, and DE, with a curved section BC joining AB and CD. Differences between different greases are shown in the slopes of the various sections, the sharpness of the curvature of section BC and the relative positions of the curves.

The section AB corresponds to the condition of flow where the grease slides as a solid plug on an exceedingly thin film of oil at the wall of the viscometer. At point B, there is a sudden transition from the linear section AB to the curved section BC. This transition corresponds with the first breakdown of the grease structure and the value of the shearing stress (F) at point B therefore measures the yield stress of that structure.

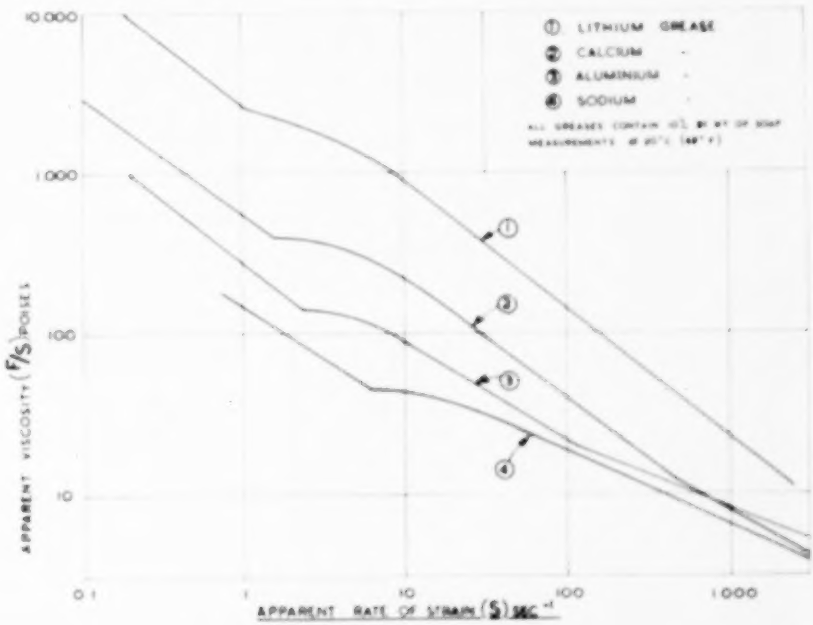
As already mentioned, the relationship between the shearing stress (F) and the calculated apparent rate of strain (S) is not unique when slip occurs at the wall of the tube or annulus. The position of section AB of the curve will depend, to some extent, on the dimensions of the viscometer used. The dimensions of both the viscometer and the particular pipe concerned must therefore be taken into account when applying data given by this part of the curve to the flow of grease in pipes. With most commercial greases, however, it is only rarely that practical problems involve conditions of flow subject to this complication.

It should be pointed out that the above considerations do not affect the significance of point B. Breakdown of the grease structure will occur wherever the shearing stress exceeds the yield stress and measurements have shown that the value of (F) corresponding with point B is independent of the dimensions of the viscometer. A fuller discussion of the phenomena of flow in the region of point B has been given elsewhere[7].

Over the section BC, normal flow of the grease is rapidly established and, except in the neighborhood of point B, this curve, and the sections which follow, will correspond to a unique relationship between (F) and (S). As the rate of strain increases, the curved section BC leads to the linear section CD, which is usually of most interest in relation to practical flow problems. In the neighborhood of point (D) there is a very rapid decrease in the rate at which the viscosity diminishes with increasing rates of strain and the curve is continued by the linear section DE which shows a considerably lower slope than that of the section CD. Although, for convenience, the linear sections CD and DE are drawn to intersect sharply at the point D, the experimental data would be more accurately represented by a short, smooth, curve connecting the two linear sections. The nature of the structural change which occurs in the neighborhood of point D is not known but it may well represent a characteristic of the grease which is as fundamental as the yield stress corresponding to the first breakdown of the structure.

Fig. 2 gives examples of viscosity curves for calcium, lithium, sodium and aluminum greases tested at 20°C (68°F). These greases all contain 10% by weight of soap prepared from the same fatty acids and were made with the same oil base, having a viscosity at 20°C (68°F) of 0.65 poises. It will be seen that the lithium grease has a much higher viscosity than the other greases at any given rate of strain, while the sodium grease has the lowest viscosity. The slopes over the different sections of the curves vary considerably

FIG. 2
Influence
of metal
base
on viscosity
of grease.



with the type of grease and are characteristic of the metal base.

The influence of temperature on the flow curves is illustrated for a calcium grease in Fig. 3. In this case, as with most types of greases, the general shape of the curve changes little with temperature. The viscosity at a given rate of strain increases as the temperature decreases and the curve becomes displaced in such a way that the shearing stresses at which the various transitions occur remain substantially the same. This suggests that the strengths of the main bonds within the soap structure are little affected by temperature and indicates that, from the rheological point of view, viscosities of greases should be compared at the same shearing stress rather than at the same rate of strain.

To compare the effects of temperature on the viscosities of different greases, the following relationship, which is the basis of the ASTM Viscosity Chart, may be used.

$$m = \frac{\log\log(\nu_{t_1} + 0.6) - \log\log(\nu_{t_2} + 0.6)}{\log t_1 - \log t_2} \qquad (4)$$

where ν_{t_1} and ν_{t_2} are the viscosities of the oil in centistokes at temperatures t_1 and t_2 respectively, measured in degrees of absolute temperature.

For a normal lubricating oil, the value of (m), which is negative, remains constant over a wide range of temperature intervals: the numerical value of (m) gives a measure of the temperature susceptibility of the viscosity, the susceptibility being greater as the numerical value is higher. Although the value of (m) for a grease may vary appreciably over different temperature intervals, the values calculated for a certain temperature interval may be used as a means of comparing the temperature susceptibilities of different greases over that interval. In Table I, values of (m) corresponding to temperature intervals of 0°C - 20°C and 20°C - 40°C are given for sodium, calcium and aluminum greases, using figures for viscosities measured at constant values of shearing stress.

TABLE I. COMPARISON OF TEMPERATURE SUSCEPTIBILITIES OF DIFFERENT GREASES

Values of (m) — Ref Equation (4)

SHEARING STRESS dynes/cm²	SODIUM 0°C-20°C	SODIUM 20°C-40°C	CALCIUM 0°C-20°C	CALCIUM 20°C-40°C	ALUMINUM 0°C-20°C	ALUMINUM 20°C-40°C
1,000	—3.1	—2.9	—1.5	—2.0	—4.4	—1.6
2,000	—3.3	—3.0	—1.6	—2.1	—4.7	—2.6
5,000	—3.8	—2.9	—3.2	—2.1	—3.7	—3.6
10,000	—4.1	—2.7	—3.3	—2.9	—3.5	—3.8

The greases mentioned in Table I were all made with the same oil, showing an (m) value of —4.4. It appears that, under most conditions, the temperature susceptibility of the grease is considerably less than that of the oil with which it is compounded. It also appears that, under the same shearing stress, the flow of different types of greases may show big differences in temperature susceptibility. In applying viscosity data to practical flow problems it is therefore essential to make viscosity measurements in the laboratory to cover the range of temperatures likely to be experienced in practice.

4. VALIDITY OF APPLYING VISCOSITY DATA TO FLOW IN PIPES

The validity of applying viscosity data to the flow of grease

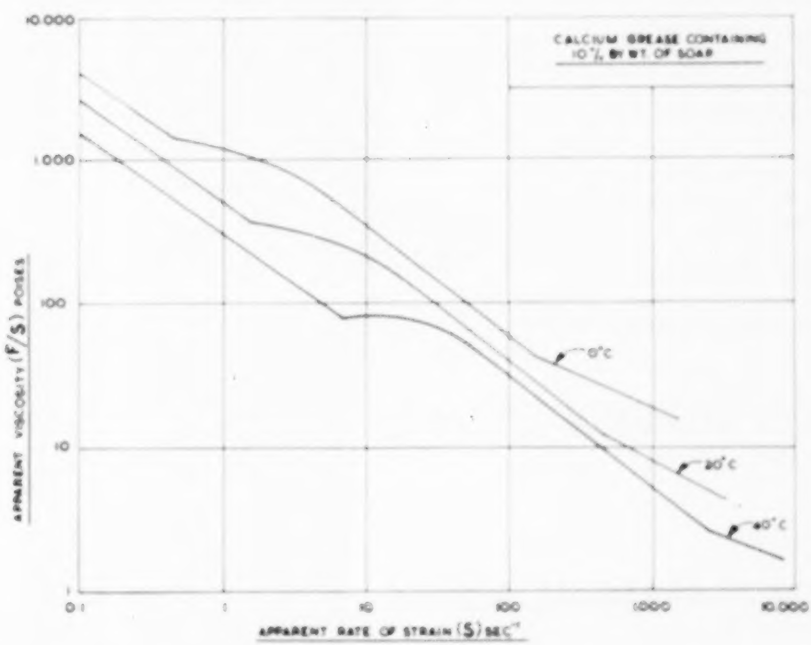


FIG. 3 Influence of temperature on viscosity of grease.

in pipes may be checked by pumping a grease of known viscosity characteristics through pipes of known dimensions under accurately-measured conditions and comparing the practical findings with the theoretical predictions.

An experiment of this kind was made using a number of pipes of known length and diameter connected in series. The diameters were estimated viscometrically, with an oil of known viscosity. These values were found to be in good agreement with those determined by direct measurement.

The pipes were coupled together and connected to a Farval manual pumping unit operated at a steady gauge pressure (420 p.s.i.). After thoroughly flushing the pipes with grease under this pressure, measurements of flow rate were made. Grease flowing from the end of the composite line was collected during 15 sec of each full stroke, which occupied about 20 sec, and the total amount of grease delivered by four successive strokes was weighed. From a number of such tests, the mean flow rate was determined as 5.8 ± 0.2 gram per minute. The portions of grease collected were bulked and filled into a plunger viscometer for viscosity measurements at the temperature of the pumping test (66°F).

The apparent rates of strain (S) occurring in the different sections of the composite line were calculated from the observed rate of flow and the corresponding shearing stresses (F) estimated from the experimental viscosity curve. The pressure drops along each section of the line were then calculated, using Equation (1). Detailed results of these calculations are given in Table II, with the comparison between the calculated total pressure drop and the observed pressure drop.

TABLE II. FLOW OF GREASE IN COMPOSITE LINE

Flow rate (Q) = 5.8 g per minute = 0.205 oz per minute

SECTION NO.	DIAMETER (inches)	LENGTH (feet)	S, sec⁻¹ (Ref. Eq(2))	F dynes/cm² (from curve)	P.p.s.i. (Ref. Eq(1))
1	0.128	3.92	30.9	10,830	232
2	0.178	3.93	11.4	8,210	126
3	0.236	1.98	4.9	5,810	34
4	0.252	2.46	4.0	5,410	37

Total Pressure Drop:

Calculated = 429 p.s.i.

Observed = 420 p.s.i.

The agreement between the observed and calculated values of the total pressure drop is good. Although the scale of the pumping test described is small compared with many practical applications, the results suggest that the use of flow data obtained in a viscometer with an annulus of only a few thousandths of an inch in width to predict flow in pipes up to ¼" in diameter is fully justified and it is concluded that, in principle, viscosity data may be applied to practical flow problems involving pipes of any dimensions.

The above statement must be considered in relation to the conclusions of Wilson and Smith who recently reported[7] that viscosities under practical conditions were less than those determined in the laboratory, the difference being a function of the residence-time of the grease in the pipe. Their paper gives a method of allowing for this difference, which is

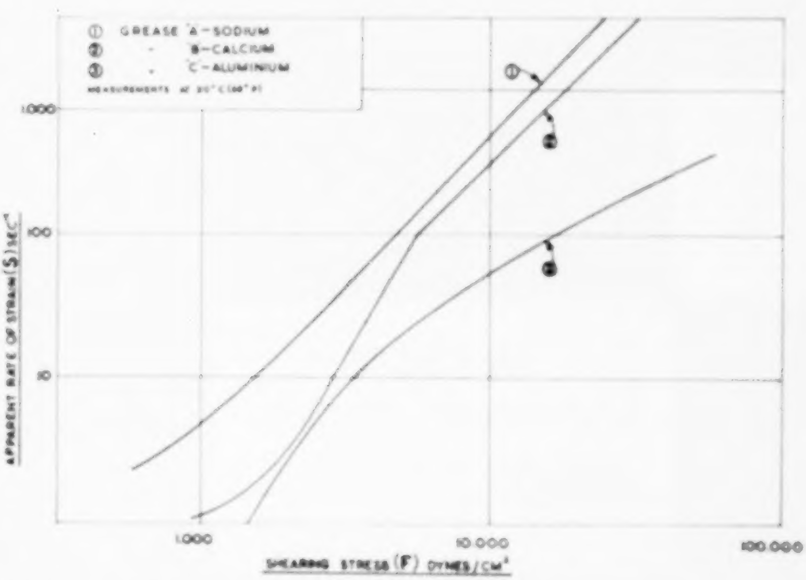
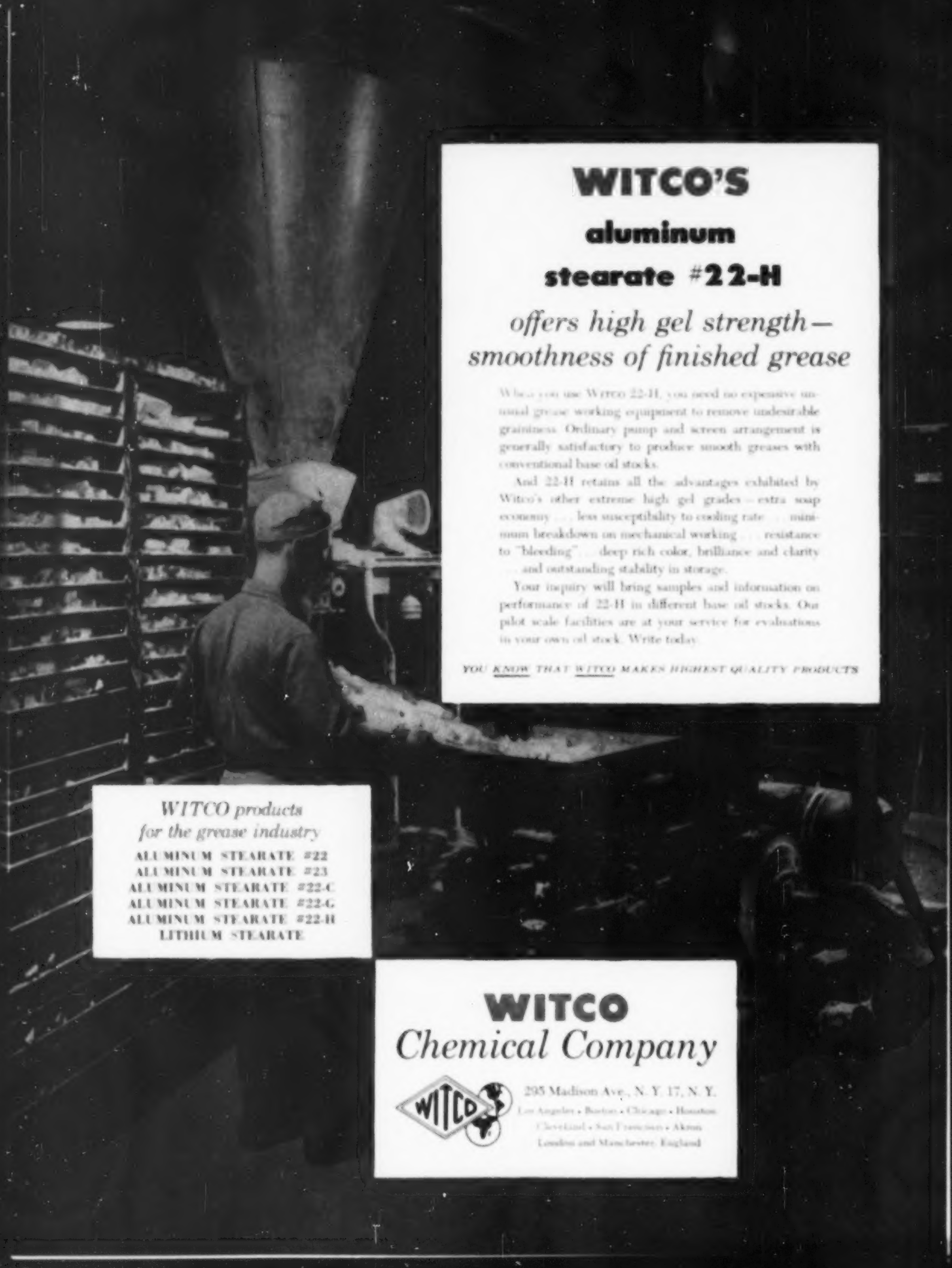


FIG. 4 Shearing stress-rate of strain relationship for greases A, B, C used in numerical examples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stated to be caused by softening of the grease during flow.

Although numerous examples are known of greases which become softer, and others which become harder during flow, it is our experience, as has already been stated, that most commercial greases, after working in the grease worker, show little strain thixotropy in subsequent viscosity measurements. It seems improbable that continuous and severe breakdown will occur, in general, when such materials are pumped in practice and the greases examined by Wilson and Smith may have been somewhat exceptional in this respect. Part of the discrepancy observed by them arose from the fact that their laboratory viscosity data were obtained with the S.O.D. viscometer, where the ratio of the length of the capillary to its diameter is only about 40 and the residence time correspondingly short. In this connection it should be noted that the ratio of the length to the width of the annulus in the viscometer used in the present work was about 800.

While the effect discussed by Wilson and Smith may be of importance with certain greases, it must be considered in relation to the big variations in rate of flow which may result in practice from comparatively small variations in pumping conditions. Thus, for example, a change of 5% in pressure gradient may cause a change of about 20% in the rate of flow with a calcium grease (Cf. Fig. 2). It is felt, therefore, that a highly precise prediction of flow is not usually required in practice and that, from this point of view, normal laboratory viscosity measurements will generally give an adequate indication of pumpability.

5. INFLUENCE OF TYPE OF GREASE ON PUMPABILITY

For the purpose of this discussion it will be supposed that grease is pumped through a system consisting essentially of a single pipe of uniform bore: this condition will apply, for example, to the main distribution line in a centralized grease lubrication system. The problems that arise in this case fall, in general, under the following headings.

(a) The estimation of the rate of flow (Q) with a certain grease in a given pumping system i.e. a system where P, L and D are fixed.

(b) The estimation of the pipe diameter (D) required to give a certain rate of flow (Q) with a given grease under a given pressure gradient $\frac{P}{L}$.

(c) The estimation of the pressure gradient $\frac{P}{L}$ required to give a certain rate of flow (Q) with a given grease in a pipe of given diameter (D).

In considering the application of viscosity data to these problems, it will be supposed that, for convenience, graphs have been constructed showing the relationship between shearing stress (F) and apparent rate of strain (S) for the greases concerned. To illustrate the influence of the type of grease on pumpability, numerical comparisons will be made using viscosity data for three typical greases viz. (A), a sodium grease of ASTM penetration 307, (B), a calcium grease chassis lubricant of penetration 325 and (C), a semi-fluid aluminum grease, with a viscous base oil, having a penetration of about 380. The relationships between log S and log F for these greases are shown in Fig. 4; the figures apply, in all cases, to flow at 20°C (68°F).

(a) ESTIMATION OF RATE OF FLOW (Q) IN A GIVEN SYSTEM

In this case, the shearing stress (F) operating in the system is calculated by inserting the fixed values of P, L and D in equation (1). The value of (S) corresponding to this value of (F) may then be read off from the curve relating log S and log F and the rate of flow (Q) calculated from equation (2).

The rate of flow under a fixed shearing stress in a particular system will, of course, depend entirely on the type of grease. In Table III, relative values of (S) corresponding to different fixed values of (F) are shown for the typical greases mentioned above: the relative values are based on the value for the sodium grease at a shearing stress of 2000 dynes/cm² taken as unity. It will be obvious from equation (2) that the relative values of (S) shown in the table will also indicate the relative rates of flow with the different types of grease under the various shearing stresses in pipes of the same diameter. The figures illustrate the big influence of both the type of grease and the shearing stress on the relative rates of flow.

TABLE III. RELATIVE VALUES OF APPARENT RATE OF STRAIN (S) FOR TYPICAL GREASES UNDER THE SAME SHEARING STRESS (F)

Shearing Stress (F) dynes/cm²	Relative Values of Apparent Rate of Strain (S) Grease "A"	Grease "B"	Grease "C"
2,000	1.0	0.18	0.20
5,000	6.5	4.2	1.2
10,000	28	21	3.2
20,000	110	74	7.1

(b) ESTIMATION OF PIPE DIAMETER (D) REQUIRED TO GIVE CERTAIN RATE OF FLOW (Q) UNDER A GIVEN PRESSURE GRADIENT $\frac{P}{L}$

Using the value of the required rate of flow (Q) and the given pressure gradient $\frac{P}{L}$, a value of (D) may be found by trial which gives values of (S) and (F) corresponding to

a point lying on the experimental curve. It is possible to avoid the need for trial calculation by first plotting the experimental data for the grease in the form of the relationship between $S^{1/3} \times F$ and F. Since it can be shown, from equations (1) and (2), that $S^{1/3} \times F = 980\, Q^{1/3} \frac{P}{L}$, the given values of (Q) and $\frac{P}{L}$ may be inserted in this expression to give the equivalent value of $S^{1/3} \times F$ and the corresponding value of (F) may be read off from the graph: the relationships between log ($S^{1/3} \times F$) and log F for the greases used in these illustrations are shown in Fig. 5. The required value of (D) may then be calculated from the value of (F) by means of equation (1).

In Table IV the effect of pipe diameter on the rate of flow under a given pressure gradient of 20 p.s.i. per foot is illustrated for the three typical greases. With each grease, the rates of flow in the pipes of different diameters are expressed relatively to the flow in the pipe of smallest diameter (⅛") taken as unity. Figures applying to the case of any Newtonian liquid are included for comparison.

It will be seen that the effect of a change in pipe diameter is much greater with greases than with a Newtonian liquid, particularly in the cases of the sodium and calcium greases. The choice of a suitable pipe diameter for a given pumping system will, therefore, be much more critical with greases than with oils.

TABLE IV. EFFECT OF PIPE DIAMETER ON RATE OF FLOW (Q) UNDER A GIVEN PRESSURE GRADIENT $\frac{P}{L}$

Pressure gradient, $\frac{P}{L}$ = 20 p.s.i. per foot

Diameter of Pipe Inches	Relative Rate of Flow: Newtonian Liquid	Grease "A"	Grease "B"	Grease "C"
⅛	1	1	1	1
¼	16	31	54	22
½	256	1,050	1,720	460
¾	1,296	8,500	13,000	2,400
1	4,096	34,600	54,300	7,720

(c) ESTIMATION OF PRESSURE GRADIENT $\frac{P}{L}$ TO GIVE A CERTAIN RATE OF FLOW (Q) IN A PIPE OF GIVEN DIAMETER (D).

From the given values of (Q) and (D), the value of (S) may be calculated from equation (2) and the corresponding value of (F) read off from the curve giving the relationship between log (S) and log (F). The required value of $\frac{P}{L}$ may then be calculated from equation (1).

Table V illustrates the influence of the type of grease on the relative values of the pressure gradients required to give a rate of flow (Q) of 10 oz. per minute in pipes of different diameters. It will be seen that, as the diameter of the pipe decreases, the pressure gradient necessary to give the required rate of flow increases much less rapidly with the sodium and calcium greases than with a Newtonian liquid. This is also true with the aluminum grease for diameters down to ¼" but for diameters less than this the relative pressure gradient increases very rapidly. This is due to the fact that, while the viscosity of the semi-fluid type of aluminum grease taken for this example drops fairly rapidly as the rate of strain increases at low rates of strain, the behavior approximates more and more closely to that of a Newtonian liquid at the higher rates of strain.

TABLE V. EFFECT OF PIPE DIAMETER (D) ON PRESSURE GRADIENT $\frac{P}{L}$ REQUIRED FOR A GIVEN RATE OF FLOW (Q)

Rate of flow (Q) = 10 oz. per minute

Diameter of Pipe Inches	Relative Pressure Gradient: Newtonian Liquid	Grease "A"	Grease "B"	Grease "C"
⅛	4,096	207	86	900
¼	256	37	15	67
½	16	6.8	3.7	6.2
¾	3.2	2.3	1.7	2.0
1	1.0	1.0	1.0	1.0

6. PRACTICAL FLOW PROBLEMS

Many practical problems can be reduced, essentially, to the simple case of the flow of grease through a single pipe of uniform bore, which may be solved by the methods discussed above. Some while ago, a paper by Jennings,[2] in this journal, gave a table, based on extensive field records, which showed the pressure drop per foot run for pipes of different sizes with a standard grease of 275 penetration pumped at 10 oz. per minute at 60°F. This table was recommended to be used as a guide in selecting suitable pipe sizes.

From the data given by Jennings, it is possible to calculate corresponding values of (F) and (S) for the various pipe diameters. When logarithms of these values were plotted, the points were found to lie on a straight line which ran parallel to and close to a similar line representing the viscosity data for a particular commercial calcium grease. It seems highly probable, therefore, that it would have been possible to cal-

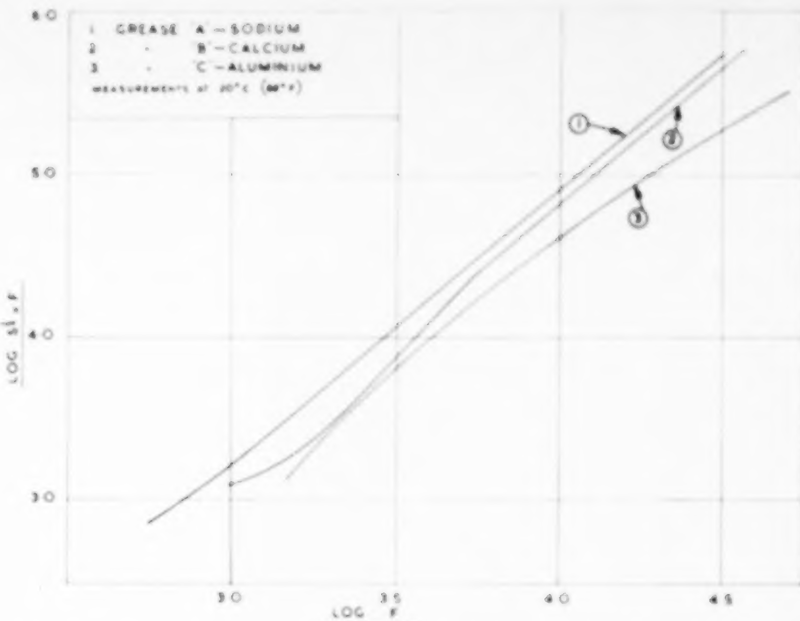

FIG. 5
Relationship
between
S1/3xF and F
for
greases A, B & C

culate reliable figures for pressure drop with the standard grease from viscosity data alone. In that case, the information need not have been limited to a fixed rate of flow. A graph showing the relation between (F) and (S) for the standard grease would have allowed pressure drops to be calculated for any pipe diameter at any rate of flow of practical interest. The examples which have been discussed above, however, emphasize the fact that the calculated pressure drops would apply only to the particular grease for which the viscosity curve had been determined and that figures for another grease, even of the same penetration grade, might be very different.

An important example of a practical problem of a more complicated nature is provided by the case of the automotive lubricator, powered by an air engine and including a gun with a flexible hose and a number of swivel unions and elbows. This system is equivalent to a number of pipes, varying greatly in length and diameter, connected in series. The rates of strain occurring in the various sections will cover a wide range and in certain sections, for example, in parts of the gun, may reach very high values which are difficult to attain in laboratory viscosity measurements. A further complication is due to the fact that the operation of the pump causes a marked pulsation in the flow, so that the rate of strain in each section of the line varies during each cycle of the pump. In such cases the estimation of the average rate of flow (Q) corresponding with a given pressure drop (P) is a matter of considerable difficulty and it may sometimes be sufficient to adopt the viscosity curve of a grease which is known to pump satisfactorily as a standard to which the viscosity curves of other greases may be referred in making a qualitative estimate of their pumpability.

The problem of the flow of grease under a steady pressure through lines of different diameters connected in series or through a system consisting of a main line with a number of branch lines, can be solved from a knowledge of the relationship between (F) and (S) for the grease, although it may give rise to complicated and tedious trial calculations. The estimation obtained will, however, give a reliable guide in selecting greases suitable for use in a given system or in designing a system to convey a particular type of grease.

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3. Beerbower, A., Sproule, L. W., Patberg, J. B., and Zimmer, J. C., Inst. Spokesman, 6, No. 8, 9, (1942), No. 10, 11, (1943).

4. Amner, J. W., and Blott, J. F. T., contribution to "Principles of Rheological Measurement" 1946, p.25.

5. Blott, J. F. T., and Bonnot, W. B., Proc. Int. Congress on Rheology-Holland 1948, II-265.

6. Wilson, J. W., and Smith, G. H., Ind. Eng. Chem. 41,770 (1949).

7. Jennings, A. J., Inst. Spokesman, 10, No. 6, (1946).

ANNUAL BANQUET

Exactly 300 attended the annual banquet.

Immediate past president B. G. Symon, presents the presidential gold key to the retiring president, A. J. Daniel and congratulates him for his outstanding leadership and service to this industry.

GENERAL SESSION

369 delegates registered for the largest N.L.G.I. meeting ever held. Here is a view of one of the general sessions.

18th N. L. G. I. MEETING BREAKS ATTENDANCE RECORDS

"LARGEST AND BEST" summed up the enthusiastic approval of all delegates attending the 18th N.L.G.I. Annual Meeting held at the Edgewater Beach Hotel October 30, 31 and November 1, 1950.

A. J. DANIEL KEYNOTES MEETING

Keynoting the event, retiring President A. J. Daniel, in his address of welcome, significantly said. "The cancerous inroads made by proponents of regimented systems on free enterprise have presented a serious challenge. But through organizations such as the N.L.G.I. we can strengthen freedom's cause by increasing our advantage of technical and productive superiority, a deciding factor in the struggle which lies ahead." His entire address constantly stressed not only N.L.G.I. benefit to its members, but the benefit to the entire nation. Attendance at the meeting and Annual Banquet held Tuesday evening smashed all attendance records. A total of 369 delegates were registered and an even 300 men and women attended the Annual Banquet.

RETIRING PRESIDENT RECEIVES GOLD KEY

Concluding an unparalleled year of constructive leadership, Mr. Daniel was presented with a gold key commemorating his service to this industry. The presentation was made by Mr. B. G. Symon, immediate past president, following the banquet. During the past two years it has been the custom of the N.L.G.I. to present the retiring president with a gold key bearing his name and year of industry service.

General concensus of opinion was that all papers delivered were highly practical and a tribute to Mr. Howard Cooper, Chairman of the 1950 Program Committee. Leading the parade of excellent addresses was "New Frontiers Through Research" by Dr. H. A. Leedy, Vice President and Director, Armour Research Foundation of Illinois Institute of Technology. Selection of the most popular and best paper delivered would be impossible. All of them received considerable notice in the Chicago newspapers as well as the petroleum press and Chicago Journal of Commerce.

Although more preprints were furnished this year than during any previous session, the demand was so great that only a few copies of some of the talks remain and are available to the N.L.G.I. office. If anyone wishes a copy, please

(Continued on page 38)

N.L.G.I. OFFICERS AND DIRECTORS

Left to right: L. W. McLennan, director; T. G. Boehmer, Chairman of the Technical Committee; H. P. Hobart, J. R. Corbett, H. A. Mayor, B. Cobisciotti, directors; G. E. Merkle, vice president-elect; C. B. Karns, treasurer-elect; A. J. Daniel, retiring president; H. F. Bennetts, executive secretary; Howard Cooper, president-elect; W. W. Albright, M. R. Bower, H. L. Hemmingway, W. H. Oldacre, W. H. Saunders, Jr., B. G. Symon, P. V. Keyser, Jr., and F. E. Rosenstiehl, directors.

NEW OFFICERS

1951 N.L.G.I. Officers, left to right: G. E. Merkle, vice president; Howard Cooper, president; and C. B. Karns, treasurer.

1950 - FUTURE MEETINGS OF YOUR INDUSTRY

NOVEMBER

2-3 Socy. of Automotive Engineers (diesel engine meeting) Hotel Knickerbocker, Chicago, Ill.

3-4 Socy. of Rheology (annual meeting) Hotel New Yorker, New York, N. Y.

9-10 Socy. of Automotive Engineers (fuels and lubricants meeting) Mayo Hotel, Tulsa, Okla.

10 American Iron and Steel Inst. (regional technical meeting), Hotel Mark Hopkins, San Francisco, Calif.

11-13 OIL INDUSTRY INFORMATION COMMITTEE Biltmore Hotel, Los Angeles, Calif.

13-14 AMERICAN PETROLEUM INSTITUTE (Lubrication Committee), Biltmore Hotel, Los Angeles, Calif.

13-16 AMERICAN PETROLEUM INSTITUTE (30th annual meeting) Biltmore Hotel and the Ambassador, Los Angeles, Calif.

13-17 Nat'l. Electrical Manufacturers Assn., Chalfonte-Haddon Hall, Atlantic City, N. J.

26 to Dec. 1 American Socy. of Mechanical Engineers Hotel Statler, New York, N. Y.

27-29 American Standards Assn. Waldorf-Astoria Hotel, New York, N. Y.

27 to Dec. 2 19th Exposition of Power and Mechanical Engineering Grand Central Palace, New York, N. Y.

DECEMBER

3-6 American Inst. of Chemical Engineers (annual meeting), Neal House, Columbus, Ohio

4-5 Oil Industry TBA Group (1950 meeting), Edgewater Beach Hotel, Chicago, Ill.

26-31 American Assn. for the Advancement of Science (annual meeting) Hotel Statler, Cleveland, Ohio

★

1951—Future Meetings Of Your Industry

JANUARY, 1951

8-9 Kansas Oil Men's Assn. (Annual Convention), Lassen Hotel, Wichita

8-12 Socy. of Automotive Engineers (annual meeting and Engineering display) Hotel Book-Cadillac, Detroit, Mich.

22-26 American Inst. of Electrical Engineers (winter general meeting), Hotel Statler, New York, N. Y.

25-26 Northwest Petroleum Assn. (annual convention), Nicollet Hotel, Minneapolis, Minn.

FEBRUARY, 1951

20-21 Kentucky Petroleum Marketers Assn. (annual meeting, convention, and trade show), Brown Hotel, Louisville, Ky.

27-28 Wisconsin Petroleum Assn. (annual convention and equipment show), Milwaukee Auditorium, Milwaukee, Wisc.

5-7 Manufacturers Standardization Socy. of the Valve & Fittings Industry (annual meeting), Commodore Hotel, New York, N. Y.

6-8 Socy. of Automotive Engineers (passenger car, body, and materials meeting), Hotel Book-Cadillac, Detroit, Mich.

7-9 AMERICAN PETROLEUM INSTITUTE (Division of Production, Southwestern district meeting), Hotel Beaumont, Beaumont, Texas

8-9 Indiana Independent Petroleum Assn. (spring convention and refiners and suppliers exhibit). Hotel Severin, Indianapolis, Indiana

APRIL, 1951

11-13 American Inst. of Electrical Engineers (district No. 4 meeting), Miami, Fla.

16-18 Socy. of Automotive Engineers, (national aeronautic meeting and aircraft engineering display), Hotel Statler, New York, N. Y.

16-18 American Socy. of Lubrication Engineers (annual convention—annual lubrication show) Bellevue-Stratford Hotel, Philadelphia, Pa.

18-20 National Petroleum Assn. Hotel Cleveland, Cleveland, Ohio

23-24 Industrial Accident Prevention Assn. (annual convention), Royal York Hotel, Toronto, Can.

30 to May 3 AMERICAN PETROLEUM INSTITUTE (Division of Refining, 16th mid-year meeting) Mayo Hotel, Tulsa, Okla.

MAY, 1951

2-4 American Inst. of Electrical Engineers (district No. 1 meeting), Syracuse, N. Y.

7-10 National Fire Protection Assn., Detroit, Michigan

12-16 National Fire Protection Assn., Montreal, Quebec

13-16 American Inst. of Chemical Engineers (regional meeting), Hotel Muehlebach, Kansas City, Mo.

24-25 American Inst. of Electrical Engineers (district No. 5 meeting), Madison, Wisc.

28-29 AMERICAN PETROLEUM INSTITUTE (Division of Marketing, mid-year meeting) Cincinnati, Ohio

INHIBITED NORMALLY UNSTABLE GREASES — It appears to be a general rule that hydrogenated fatty materials employed for grease purposes are very susceptible to oxidative deterioration, presumably because of destruction of natural inhibitors during the hydrogenation operation. This is particularly so in the case of hydrogenated fish oils and fish oil acids which, in other respects, are excellent grease constituents. A patent issued to Standard Oil Development Co. (U.S. 2,522,-460) discloses that such hydrogenated fatty materials deteriorate rapidly with use due to the formation of peroxides, lactones and other oxygen bearing materials which catalyze further oxidation, resulting in rancidity, foul smelling, and separation or bleeding in storage. These acids and other oxidation products react chemically with the bearing materials and also tend to clog parts and prevent proper lubrication.

It has been found that greases containing such hydrogenated materials can be inhibited by use of certain non-toxic carbon blacks which act as oxidation inhibitors and prevent deterioration over relatively long periods of time. They also have a very high absorptive power for mineral oil and tend to form stable colloidal or grease-like structures (as already outlined in this column in the October, 1949, issue) and thus considerably improve the physical structure and stability of lubricating greases under conditions of wide variations in temperature. The carbon blacks best suited for this purpose are those possessing a high structure index. For example, acetylene black has a structure index of 300, while ordinary channel black has an index of 100. Such carbon blacks preferably have an average particle size of between 25 and 50 millimicrons and have alkaline reactions, their pH being over 7. One example of a suitable carbon black is Conductex B sold by Columbian Carbon Co.

Since there is a tendency to over-lubrication and waste, the presence of the black color is claimed to make it easier to detect and prevent use of excessive quantities, and a black grease film is readily noticed on shiny bearing materials so that it acts as an indication as to whether sufficient grease is present. Furthermore, most common anti-oxidants are very toxic and cause dermatitis and other physiological difficulties whereas the carbon blacks of the type used herein are non-toxic and incur no other difficulties.

A typical grease made according to the invention contains 15% hydrogenated fish oil of 54 titre and 57° C melting point, 5% hydrogenated fatty acids, 2.4% sodium hydroxide, 0.7% hydrated lime and 77.86% phenol-extracted low cold test mineral oil. To this is added a sufficient amount of modified channel black with pH of 9 and structure index of 200 and the effect of addition of various amounts of the black in the grease is shown by Table I.

Table I

Grease	Bomb Life, Pressure Drop (in oxygen absorbed), in lbs./in.²			
	5 *Hrs.*	10 *Hrs.*	15 *Hrs.*	20 *Hrs.*
Grease described in Example	38	40	42	42
Same + ½% Carbon black[1]	48	50	52	54
Same + 2% Carbon black[1]	128	172	232	268
Same + 4% Carbon black[1]	110	182	252	318

[1]Modified channel black, with pH of about 9, srtucture index 200.

It is preferable to employ a black with a structure index of above 100, preferably of about 200 or higher, and in most cases 0.3-0.5% is sufficient. Among the soap compounds which may be used are lime, sodium, lithium, aluminum, and zinc and the soap content may vary within the usual limits of 5-30% by weight.

Figure 1 shows the high temperature-pressure viscosity of a grease base stock with and without carbon black addition. It will be noted that the viscosity drops off much less rapidly at higher temperatures in the case of the lubricant containing carbon black. On the other hand, at normal temperature the carbon black composition has a lower viscosity than the standard lubricant without the black, an effect which is said to be surprising.

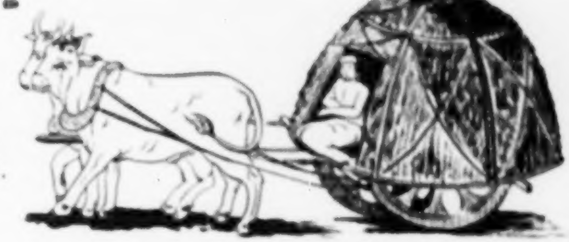
SODIUM-BARIUM GREASES FOR ANTI-FRICTION BEARINGS—A mixed base sodium-barium soap grease particularly suited for lubricating high speed anti-friction bearings over a broad temperature range has been disclosed in U.S. patent 2,514,330 issued to Standard Oil Development Co. This patent points out that a previously disclosed grease covered in U.S. 2,245,702 made with soda and baryta had given fairly satisfactory lubrication but had certain deficiencies in that it was not useful over a wide temperature range as desired. It was found that unexpected improvements may be obtained by employing fatty acids of lower average molecular

GREAS-EVENTS

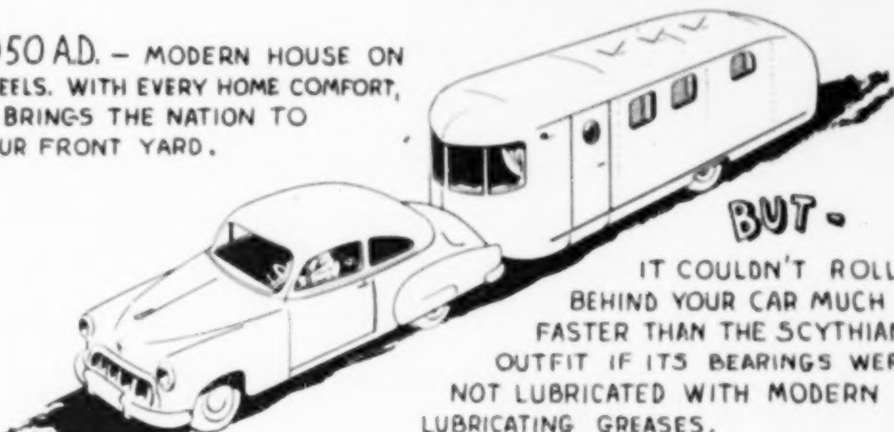
Here is a feature you can reproduce in your own publication. An electro can be made from this drawing to fit your particular page. Tell the story of your industry in picture form.

Greas-Events

HOUSES on WHEELS --



200 B.C. - THIS HOUSE ON WHEELS WAS USED BY THE SCYTHIANS WHO ROAMED THE COUNTRY NORTH OF GREECE.

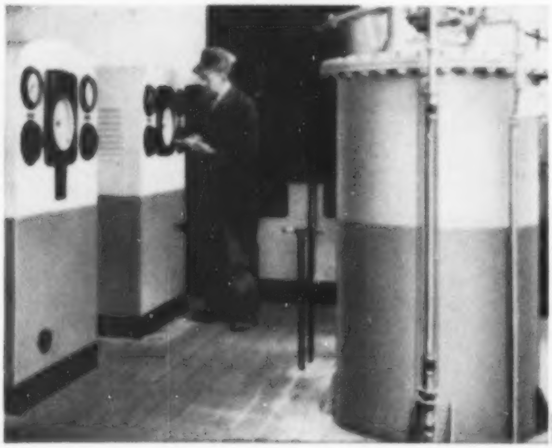


1950 A.D. - MODERN HOUSE ON WHEELS. WITH EVERY HOME COMFORT, IT BRINGS THE NATION TO YOUR FRONT YARD.

BUT -

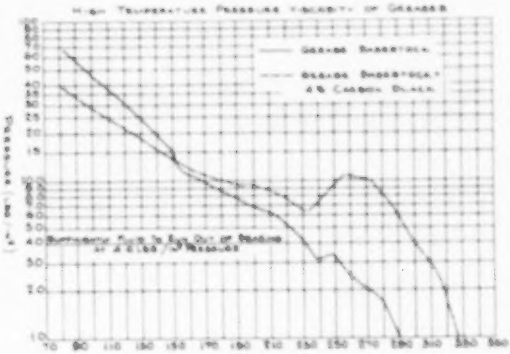
IT COULDN'T ROLL BEHIND YOUR CAR MUCH FASTER THAN THE SCYTHIAN'S OUTFIT IF ITS BEARINGS WERE NOT LUBRICATED WITH MODERN LUBRICATING GREASES.

LABORATORY PRECISION HAS DONE THE JOB !! "SPEED" AND "MOBILITY" MEAN LUBRICATING GREASE. THIS LABORATORY EXAMINES AND PERFECTS MODERN LUBRICATING GREASES FOR MODERN USE.



weight than acids used in the prior art and by employing a base lubricating oil of high viscosity index. Also, it was found that if the finished grease contains a small amount of free acid rather than free alkali (as was the case in the patent mentioned), a change in physical structure of the grease is permitted at high temperature, which makes the lubricant suitable for anti-friction bearings running at high temperatures.

It is a well known fact that most lubricating greases pass through a change of phase at a temperature in the approximate vicinity of the melting point of the fat or fatty acid from which the thickening soap is prepared. The phase change



occurring at this point, i.e. the uni-dimensional melting point of the soap, is slight. However, at higher temperatures another phase change occurs, which is due to increased thermal energy in the soap lattice and is called the bi-dimensional melting point. This expression defines the phenomenon by which a soap structure which exists in three dimensions breaks down in the second of such dimensions. At such a phase change or transition point, lubricating greases lose their short fibered smooth structure and become very fibrous and rubbery in character. If the change in phase occurs in a grease below the desired operating temperature, the grease is not a good lubricant.

It was discovered that this could be accomplished by using a fatty acid of shorter chain length or lower molecular weight in producing the grease from a soap. Such a reduction in molecular weight also decreases the solvency of the soap in the mineral oil. Also, by using more aliphatic type mineral oils (paraffinic rather than naphthenic or aromatic), the soap solvency in the oil is further decreased. This further raises the temperature at which phase change or transition takes place. As a result of these factors, greases of a desired consistency or hardness may be obtained with relatively less soap. Thus the soap content may be as low as 3-4%, although it may also go as high as 25-30% by weight if a stiff lubricant is desired.

One example of a grease made according to the invention contains 12.5% hydrogenated fish oil fatty acids (predominantly palmitic), 1.7% sodium hydroxide, hardness and consistency. Apparently the addition of a saturated fatty acid overcomes the tendency of aluminum soap greases to break down unduly under shearing stress. A grease of good shear stability, produced by continuous methods involving rapid cooling, was compounded comprising 6% aluminum stearate of commercial grade and 1.2% of hydrogenated fish oil acids which are substantially saturated acids having 12-22 carbon atoms per molecule. As a modifier, 0.56% iso-octyl phenol is added, the soap and modifier being mixed into about 92% of a low cold test mineral oil having a viscosity of 900-1000 SSU at 100° F. with addition of a small amount, about .25%, of a tackiness agent such as an oil solution of polybutene.

A specific composition which is claimed contains 91-93% of mineral lubricating oil, 6-7% aluminum stearate, .6-1.2% hydrogenated fish oil acids which are substantially saturated and have 12-22 carbon atoms per molecule, and .6-.7% iso-octyl phenol.

POLYALKYLENE GLYCOL GREASES—Millet of Carbide & Carbon disclosed several new greases produced from polyalkylene glycols. One has been successfully used at temperatures as high as 250° F and as low as —70° F, while another is specifically designed for high temperature service. These Ucon lubricants were found to possess marked anti-wear properties (J. Commerce 9/5/50 p.23).

A study of calcium stearate monohydrate-cetane gels was made by Vold and others (Paper ACS Meeting, Chicago 9/3/50 p.13G).

Moore and others also studied the mechanical breakdown of soap base greases (ACS Meeting 14G), while the boundary lubrication of steel with blends of esters, .78% barium hydroxide octahydrate, .4% phenyl-alpha naphthylamine antioxidant, 71.87% extracted Panhandle distillate (150 vis./100, SUS) and 12.8% extracted Coastal distillate (80 vis./100, SUS). Since acids such as lauric, myristic, or palmitic may be used in mixtures with each other or with stearic acid, as desired, to obtain the proper average, the average being slightly less than the composition of stearic acid, i.e. 18 carbon atoms, the presence of a small amount of free fatty acid was found to substantially improve the high temperature performance without detriment to the oxidation resistance or shear stability. Evidently the free acid has some solvency effect preventing the grease from becoming rubbery at high test temperature.

ALUMINUM SOAP GREASES—Another Standard Oil Development Co. patent (U.S. 2,521,395) discloses an improved aluminum soap base lubricating grease suitable for use on chassis, etc. and is modified to improve its texture and also adapted to be produced by modern methods involving continuous processing with rapid cooling. Such a grease is claimed to have desirable characteristics and consistency in withstanding the use of rapid cooling techniques. It was found that without grease structure modifiers, grease produced by the continuous and semi-continuous apparatus employing quick cooling sets up in hard crusts, resulting in graininess and considerable syneresis.

According to the patent, the addition of a substantially saturated acid in the quantity of 10-20% of the aluminum soap, together with use of an alkylated phenol modifier in reduced quantities, has been found to give a grease with reduced acids and soaps is discussed by Davey (Industrial Engrg. Chem. 9/50 p.1837).

The September, 1950 issue of Lubrication published by the Texas Co. is devoted entirely to grease application devices.

Morehouse Industries of Los Angeles is advertising its new speed-line mill, especially designed for lubricants and com-

(Continued on page 28)

GREASONALITIES

LEFFINGWELL CHEMICAL COMPANY JOINS N.L.G.I.

D. E. MURPHY

At the turn of the century the Leffingwell Company was organized. In January 1934 the Westwell Chemical Company, a subsidiary, was founded to engage in the manufacture of Metallic Soaps, and spray dried chemical products, under the label "Westwell Brand." After having been known for 50 years as the Leffingwell Company the name was recently changed to Leffingwell Chemical Company, which more adequately describes the broader field of activities in which the company is now engaged.

Leffingwell Chemical Company is located in Whittier, California, a progressive little city located 12 miles east of metropolitan Los Angeles. Incidentally, the City of Whittier was founded about 65 years ago by a colony of Friends, and was named in honor of John Greenleaf Whittier, their famous Quaker poet.

D. E. Murphy, sales manager agricultural and industrial chemicals, will be their NLGI representative. He attended the University of Detroit, and the Detroit Institute of Technology, receiving a Bachelor of Science, graduating in June 1931.

Following graduation, employed as chemist by the Beryllium Corporation of America, and later with the Harshaw Chemical.

After 10 years with the sales department P.M.C. division of Hercules Powder Company, joined Leffingwell Chemical Company June 1948 as Sales Manager of the Industrial Chemical Department, and in January 1950 appointed General Sales Manager of the company.

Mr. J. R. Allison, the Director of the Research and Development laboratories, received his Bachelor of Science in Chemical Engineering from the University of California. He is assisted by Mr. William L. Blalock who received his B.A. from the University of Indiana, and his M.S. in Chemistry from the University of Southern California. Mr. Howard F. Keller received his B.A. in Chemistry and is a graduate of Pomona College.

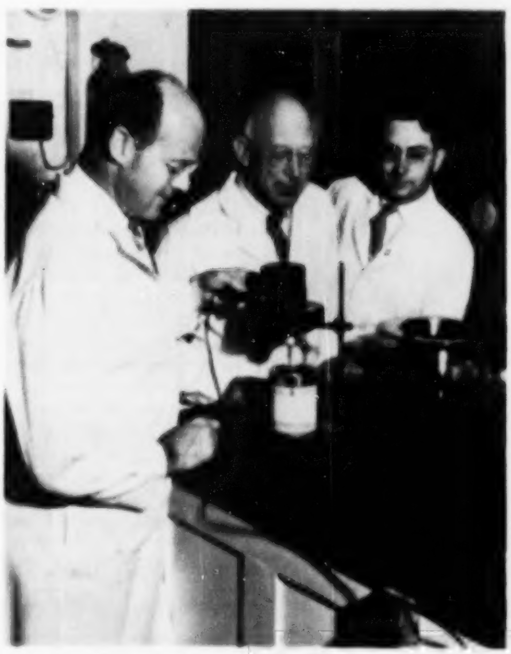
Laboratory facilities for the development of new and improved Metallic Soaps, and allied chemical products, and the control of uniformity in manufacturing are maintained. As a special service for the petroleum industry located on the West Coast a complete laboratory with pilot scale equipment is maintained for the study, investigation and applied use of Aluminum Stearate, and other Stearates used in grease formulations. Close co-operation between Leffingwell Chemical Company and the West Coast petroleum industry has been mutually beneficial. In view of what has been accomplished to date, continued progress is expected toward the maximum application of Stearates in grease formulations.

This same technical service is available to the paint, varnish and lacquer industry, rubber and plastics, cosmetic industry, and other consumers of "Westwell Brand" Stearates and Palmitates.

Leffingwell Chemical Company maintains membership in the National Lubricating Grease Institute, American Chemical Society, Los Angeles Rubber & Plastic Society, and the Federation of Paint & Varnish Production Clubs.

"Westwell Brand" products constitute a wide variety of Stearates and Palmitates, available for West Coast industries. Every product from the oldest to the newest must measure up to the company's 16-year reputation, a reputation for uniform quality.

At the present time the Leffingwell Chemical Company manufactures Stearates of Aluminum, Barium, Calcium, Lead, Magnesium, and Zinc. It is also a producer of Aluminum and Zinc Palmitates. In the latter part of 1948 two new products were introduced, Aluminum and Copper Okto-8, the tri and di salt respectively of 2-Ethyl Hexoic Acid.



J. R. Allison, center, newly appointed technical representative for Leffingwell Chemical Company, is shown with William Blalock, right, and Howard Keller, left.

Marketing of "Westwell Brand" Stearates, Palmitates and allied chemical products is limited to the West Coast, and distribution points are maintained at Los Angeles, San Francisco, Portland, Oregon and Seattle, Washington.

DEEP ROCK OIL CORP. APPOINTS WESTBROOK FOR WISCONSIN AREA

JAMES H. WESTBROOK

James H. Westbrook has been appointed assistant to Walter J. Schroeder, manager of the Wisconsin sales area of the Deep Rock Oil Corporation, it is announced by B. L. Majewski, vice president in charge of marketing.

For the past two and one-half years Mr. Westbrook has been manager of personnel and industrial relations for Deep Rock with headquarters at Tulsa, Oklahoma. During this period he has devoted much time to organization studies and has just completed an organization survey of its marketing division.

A graduate of the University of Kentucky school of Business Administration, Mr. Westbrook has been associated with several companies with outstanding merchandising and sales organizations, including Kroger Grocery & Baking Company and Swank, Inc. Immediately before joining Deep Rock he was associated with Booz, Allen and Hamilton, management consulting firm of Chicago.

Mr. Westbrook will make his headquarters in Milwaukee.

L. F. McKAY TO REPRESENT OHIO CORRUGATING IN N. L. G. I.

L. F. McKAY

As reported previously in The Institute Spokesman, The Ohio Corrugating Company of Warren, Ohio, manufacturers of steel shipping containers—drums and pails—is a new associate member in the N.L.G.I. The company's vice-president, L. F. McKay, will be the company representative.

Active Mr. McKay is the chairman, Research and Development Committee of the Steel Shipping Container Institute, Inc., as well as a member of the Specifications and Simplified Practices Committees.

Advisor to the Sub-Committee on Metal Drums and Packages of the Packaging Institute, Inc., and now sitting with the Metal Packages Committee of the Manufacturing Chemists Association.

For years, Operating Vice President of the J & L Steel Barrel Company (a Jones & Laughlin Steel Corporation subsidiary), Executive Vice President of Wackman Welded Ware Co., one of its predecessors, and Corporation Secretary and Factory Manager, American Flange & Manufacturing Company, Chicago, makers of the "Trisure" closure and other fittings for steel drums.

Born February 27, 1906, in Onaway, Michigan, and educated as an Industrial Engineer. Married — one son.

Supervised the construction and layout of several steel container plants, built and designed drum making equipment and for years actively engaged in market research and development in the steel shipping container field. *Chemical and Engineering News* recently published his paper on "Linings for Steel Shipping Containers" as presented to the American Chemical Society.

Recently appointed a temporary member of the faculty of Temple University in connection with the symposium on packaging problems to be held during the Industrial Packaging and Materials Handling Exposition in Philadelphia October 10, 1950.

RINKLE OF INTERNATIONAL LUBRICANT DIES

THE SPOKESMAN regrets to announce that Weldon Rinkle, jobber sales manager for International Lubricant Corporation, New Orleans, Louisiana, passed away October 23. Burial services were held October 25 at New Orleans. Mr. Rinkle was instrumental in organizing the International Lubricant Corporation in 1929, and had been connected with the oil and grease industry for about 30 years. He was a World War I veteran.

PATENTS AND DEVELOPMENTS

(*Continued from page 25*)

pounds, with production capacity of 8000 lbs. per hour of milled and deaerated greases (Chem. & Engrg. News 9/11/50 p.3163).

A survey conducted by the API discloses that the ratio of gasoline with oil and grease consumption in motor vehicles has increased, reflecting the improved quality of lubricants (J. Commerce 9/19 p.14).

DuPont is advertising its Ortholeum 300 grease stabilizer available in brown flakes, melting point 125-60° F, and claimed to be markedly more effective over compounds such as phenyl-alpha-naphthylamine, particularly in catalyzed systems. (Petr. Refiner 9/50 p.74).

MECHANIZED GREASE DISPENSER—A mechanized grease dispenser which operates from any power take-off, as a Jeep installation, is being made available by Engineered Lubrication Eqt. (Nat'l Petr. News 7/26/50 p.25).

SOLUBILIZERS FOR HYDROCARBONS IN SOAP SOLUTIONS—Use of long-chain alcohols such as n-heptanol through n-dodecanol, as additives markedly increases solubilization of n-heptane in potassium tetradecanoate solutions. Addition of potassium chloride to potassium tetradecanoate results in an enhancement of solubility of n-heptane and a decrease for n-octanol (Klevens, J. Amer. Chem. Soc. 8/50 p.3581).

Shell Oil Co. has published "The Fundamentals of Lubricating Greases And Their Applications". (Oil, Paint & Drug Rep. 8/14 p.47).

(*Continued on page 36*)

E. V. MONCRIEFF DIES

Ernest V. Moncrieff, 60, of Rye, New York, former president of the Swan-Finch Oil Corporation, 30 Rockefeller Plaza, died November 5 at United Hospital in Port Chester.

Born in Toronto, Mr. Moncrieff was graduated in 1910 from the Nichols School in Buffalo and in 1914 from Harvard University. He served in the field artillery in World War I, emerged a major and won the Distinguished Service Cross and the Croix de Guerre.

ERNEST V. MONCRIEFF

With the Swan-Finch company for more than thirty-five years, he served as its president from 1930 to 1948. He continued as a director of the company, and had recently established his own real estate business in Rye. He was a past president and treasurer of the National Lubricating Grease Institute.

Mr. Moncrieff was one of the founders and the first president of the Westchester-Greenwich Harvard Club, a past president of the Rotary Club of New York, a trustee of the Hackley School in Tarrytown, a member of the executive committee of the World Alliance for International Friendship Through Religion and a former vestryman of Christ Protestant Episcopal Church in Rye.

He was also a member of the Apawamis, Manursing Island, Shenorock and American Yacht Clubs in Rye; the University and Metropolitan Clubs in New York; the Saturn Club in Buffalo, and the Union League Club in Chicago.

Surviving are his wife, Mrs. Lucile Lauring Calkins Moncrieff; a son, Ernest V. Moncrieff jr., and a daughter, Mrs. Austin Day Brixey jr.

THE N.L.G.I GUIDE POST

Industry CROSSROADS FOR BUYERS and SELLERS

SUPPLIERS OF MATERIALS FOR MANFACTURING LUBRICATING GREASES

MANUFACTURERS OF EQUIPMENT FOR APPLICATION OF LUBRICATING GREASES

DESIGNERS OF GREASE INDUSTRY EQUIPMENT

NEWS About Your Industry

STEWART-WARNER CORP. ANNOUNCES "SEVEN ELEVEN"

Three models of an air-operated high pressure lubricant pump, the Alemite "Seven Eleven," which will deliver lubricant from 25, 35 or 50 pound original containers, have been announced by the Alemite Division of Stewart-Warner Corporation, Chicago.

Heart of the 711 pumps is a radically new sealed-in air motor which is unconditionally guaranteed for 27 months. The motor requires no oiling and has an exclusive centered-valve design, with the air valve and related parts located between the air cylinder and pump tube. The pump has a minimum of moving parts, and is both light and compact. It weighs only nine pounds. There is no trip rod nor cam and the motor is impossible to stall, according to Alemite engineers. The pump tube is equipped with the original Alemite dynamic primer and the entire pump assembly is precision-built to close tolerances. It does not require bleeding to eliminate air pockets.

Model 711 is mounted on a black baked enamel base with 3-inch casters and a convenient pull-handle. It is 31⅝" high. The shield is 17⅜" in diameter and the base is 20⅛" square. Changing of lubricant pails is accomplished by loosening two set-screws at the base of the shield and lifting the shield, pump and hose assembly as a unit. The lubricant container is then set into a recess in the base, in which it is automatically centered, and the shield and pump and hose are set into place.

Model 711-A is mounted in a pivot-swing dolly instead of a castered base. It has eight-inch, ball-bearing wheels with semi-pneumatic tires and a bicycle-grip pulling handle. Instead of a shield, it has a lubricant container into which 25, 35 or 50 pound original pails can be placed, or which, if used as the lubricant reservoir, can hold 70 pounds of lubricant transferred from a larger original container. The cover, which supports the pump, has three clamps and a sealing ring and gives full-open head for filling or for changing of pails. It has a dirt-tight seal when closed. It can be pulled over unpaved areas, over rough or uneven floors, or up and down steps.

Model 711-B is a stationary unit without base or dolly. It has the same 70-pound capacity lubricant reservoir used on Model 711-A. It is 25⅝" high.

All three units are finished in gleaming oven-baked enamel and simulated hammered aluminum. Each has a hose assembly consisting of a Z-type swivel, six feet of high pressure hose with 20,000 lb. pressure test and one year guarantee, and, control valve with adjustable single shot or continuous flow.

The pump has positive 40 to one ratio and delivers 14½ ounces of chassis lubricant per minute at 70 degrees F. with 150 pounds of air pressure.

NOPCO WEST COAST PLANS MOVING FAST

Plans for the manufacture of its Industrial chemicals on the West Coast are moving ahead rapidly, according to a recent announcement by Thomas A. Printon, president of Nopco Chemical Company, Harrison, New Jersey.

Two Nopco-owned plants, both located in Richmond, California, will be utilized in the Pacific Division expansion program first announced last April. The company's very modern 4-year-old plant at 1141 South 14th Street is being converted to the manufacture of stearates and palmitates by Metasap Chemical Company, a wholly owned subsidiary. Equipment is now being installed and the plant is scheduled to go into production shortly after January 1, 1951. The building was formerly occupied by Rare-Galen, Inc., for the manufacture and packaging of pharmaceuticals before this subsidiary was sold by Nopco earlier in the year.

A second plant, located at 1140 South 10th Street, is being fitted for production of the extensive line of chemical processing specialties and agricultural products marketed through the company's Industrial Department. This plant was formerly devoted to Vitamin oil processing. Complete installation of industrial equipment is expected sometime before the end of the second quarter, 1951, with production beginning shortly thereafter. Present boiler house facilities will be more than adequate to handle the increased production at both plants.

As stated at the time of original announcement, the Pacific Division was established to take care of the constantly growing Metasap and Nopco business in the westernmost states of California, Washington, Oregon, Idaho, Montana, Arizona, Nevada, Utah, Colorado, Wyoming, New Mexico and the Province of British Columbia. It is the company's foremost desire to keep pace with the increasing needs of its customers in this area by providing faster deliveries and greater service, explained Mr. Printon in his release.

Further building expansion on the Coast is made possible by Nopco's ownership of a large tract of land between the two present plants. Over-all activities of the Pacific Division are guided by Perc S. Brown, vice-president, assisted by Harold A. Swanson as general sales manager.

API DIVISIONS SET MIDYEAR MEETING DATES

Dates for the 1951 midyear meetings of the Division of Refining and the Division of Marketing of the American Petroleum Institute have been approved by the Executive Committee of the API Board of Directors.

The Division of Refining will hold its midyear meeting in Tulsa, Okla., on April 30 to May 3.

The Division of Marketing will hold its midyear meeting in Cincinnati, Ohio, on May 28 and 29.

N.L.G.I. IS HAPPY . . . to have the opportunity of welcoming two new members.

The General Lubricants Company, 206 Sixth Street, N. E., Minneapolis, Minnesota, is our new active member.

Morehouse Industries, 1156 San Fernando Road, Los Angeles, California is N.L.G.I.'s new associate member.

Write-ups of interesting highlights of the two companies' histories will appear in a later issue of the SPOKESMAN, as will the names of their newly appointed representatives and Technical members.

THE MIDWEST RESEARCH INSTITUTE . . . of Kansas City, Missouri, Technical member of the N.L.G.I. is planning to add two men in the field of petroleum technology to its staff.

One of these men is to be an organic chemist with his Ph.D. degree and at least five years experience in the petroleum industry. He will succeed Mr. C. O. Dohrenwend as representative of his organization to the N.L.G.I. Technical Committee. The second man to be added to the Midwest Research staff will act as assistant in petroleum technology.

PATENTS & APPLICATIONS

(Continued from page 28)

U.S.—

2,515,460 (Josam Mfg. Co.)—Flow regulator for grease interceptors and the like.

2,515,611 (Preszler)—Flexible shaft grease fitting.

2,517,551 (American Can Co.)—Filling adapter for grease guns.

Canadian—

467,374 (Cities Service Oil Co.)—Grease dispensing units.

British Patents—

642,410 (Shell)—Lubricating grease composition.

642,948 (Shell)—Process and apparatus for cooling molten lubricating greases.

643,489 (Harvel Corp.)—Petroleum oils and greases made therewith.

DOW CORNING APPOINTS WASH. D. C. MANAGER

Dow Corning Corporation, manufacturer and distributor of silicone products, has announced the appointment of Mr. Earle J. Smith as Manager of the company's newly-opened branch office at 711 Fourteenth Street, N.W., in Washington, D.C.

Mr. Smith has a broad chemical background, receiving his Master's degree from the University of Nebraska in 1940. Before taking a position as research chemist with Dow Corning in 1945, he was an instructor in Chemistry at Michigan State College and a research chemist with the Chemical Warfare Department at The Dow Chemical Company.

Mr. Smith has been closely associated with one development of many silicone products, particularly the resinous silicones. In 1946 he was assigned to the New York office of Dow Corning as a Technical Consultant. Mr. Smith expects his Washington office to provide an efficient advisory service on the potentialities of silicone components in military equipment.

HOW TO GET

- **High Dropping Points**
- **Easily Controlled Penetration Values**
- **Outstanding Stability**
- **Increased Yields**

METASAP* STEARATES

give you the best possible grease for any grease job

Metasap's expanded laboratory facilities, with up-to-the-minute equipment for studying the behavior of grease-making soaps, permit close scientific controls that result in outstanding products . . . bases that help the lubricant manufacturer meet every specification.

Metasap research and testing laboratories.

Metasap Aluminum Stearates, for example—today's *foremost* development in grease making—offer versatile means for varying the properties of finished greases. These soaps include:

Metasap 537—a "body builder" designed to give No. 3 consistency and a short feather.

Metavis* 543—a "string builder" designed to produce any degree of stringiness desired.

Metasap 587—designed for producing soft, smooth and stable greases with low viscosity oils.

Metasap 540—particularly suitable for producing low viscosity greases for agricultural and industrial machinery.

Metasap Aluminum Stearate R, Aluminum Stearate GM, 537, 590 and 598—for producing harder greases, in the order given. (Taken consecutively, these represent increasing economy, since less of each is needed to obtain a given penetration.)

You'll find lubricants based on Metasap Stearates moisture-proof, temperature-resistant, water repellent . . . clear and uniform . . . able to do a thorough job under the toughest conditions, since they do not bleed, cake, freeze, evaporate or dissolve. And the remarkable gel-efficiency of Metasap Stearates spells economical production.

Whatever your grease requirements, therefore, consult with us. Our experience, research facilities and specialized knowledge can help you select the *correct base for any given oil* . . . or achieve any desired effect in a finished grease, through the use of proper soap mixtures. Profit by writing us today.

METASAP CHEMICAL COMPANY HARRISON, N. J.

Branches: CHICAGO • BOSTON • CEDARTOWN, GA. • RICHMOND, CALIF.

Stocks at Cleveland, Ohio; Louisville, Ky.; San Francisco & Los Angeles, Cal.; Portland, Ore.; Spokane & Seattle, Wash.

*Reg. U.S. Pat. Off.

METASAP CHEMICAL COMPANY

Stearates

of Calcium • Aluminum • Lead • Magnesium • Zinc

BARTON TO HEAD DEEP ROCK GEOLOGICAL DEPARTMENT; JENNINGS NEW ENGINEER

Jackson M. Barton, formerly director of exploration for the Cooperative Refinery Association in Kansas City, Missouri, has been appointed manager of Deep Rock Oil Corporation's geological department, according to an announcement by John L. Ferguson, vice president in charge of the company's land and exploration division.

A native Oklahoman, Barton received his B.S. degree from the University of Oklahoma in 1938, then worked for Magnolia Petroleum Company a year before continuing graduate studies at Yale. He returned to Magnolia in 1941 and served the company both in Oklahoma and West Texas for five years.

In 1946, he joined the Cooperative Refinery Association as division geologist at Wichita, Kansas. Later he moved to Kansas City as chief geologist for Cooperative and was appointed their director of exploration last September.

Well-known in mid-continent petroleum circles, Barton is a member of the American Association of Petroleum Geologists; American Institute of Mining and Metallurgical Engineers; Society of Exploration Geophysicists; American Geophysical Union and American Association for the advancement of science. He will make his residence in Tulsa with Mrs. Barton and three children.

John H. Jennings has joined the Deep Rock's staff as evaluation engineer, Richard K. Huey, vice president in charge of crude oil production announces. He had been petroleum engineer for the Ohio Oil Company's Tulsa division for the past five years.

Reared and educated in Pittsburgh, Pa., Jennings received his petroleum engineering degree from the University of Pittsburgh in 1939, and soon after started work with Sunray Oil Corporation in Tulsa. In 1942 he joined the Ohio Oil organization, and worked a year for the Mountain Fuel Supply Company at Rock Springs, Wyoming, before being transferred to Ohio's Bakersfield, Calif., division.

He left Ohio in 1944 to do private consulting work, but in 1945 rejoined the company in Tulsa where he remained until the Deep Rock appointment. He is a member of the American Institute of Mining and Metallurgical Engineers, the American Petroleum Institute's secondary recovery committee and a registered professional engineer in Oklahoma, Colorado and Wyoming.

With Mrs. Jennings and three children, he will continue residence in Tulsa.

N.L.G.I. MEETING

(Continued from page 19)

notify NLGI and requested copies will be furnished, if they are still available.

ELECTION OF BOARD AND OFFICERS

Following the regular sessions on Monday, the Annual Business Meeting was held and Active Members present unanimously elected: W. W. Albright, Howard Cooper, C. B. Karns, P. V. Keyser, Jr., G. E. Merkle, and W. H. Oldacre to serve their industry for a term of three years on the Board of Directors. On the following day the Board elected officers to represent the lubricating grease manufacturing industry. Unanimously they chose Howard Cooper as President, G. E. Merkle, Vice President and C. B. Karns, Treasurer.

TECHNICAL COMMITTEE SESSION

The Technical Committee session held on Wednesday, November 1, was exceptionally well planned and executed by Technical Committee Chairman T. G. Roehner. All presentations were contained in a program and presented in an interesting and informal manner to the entire group.

MAKE RESERVATIONS NOW

Wednesday noon saw the end of the largest and most enthusiastic N.L.G.I. Annual Meeting ever held. Already an attendance of four to five hundred delegates is being talked for the 19th Annual Meeting which will be held at the Edgewater Beach Hotel in Chicago, October 29, 30 and 31, 1951. All persons wishing to attend are urged to make hotel reservations now. This year the overflow crowd had to be accommodated at other hotels. Early reservations, and that means now, will assure you accommodations at the next Annual Meeting which probably will be another record-smashing event.

Did you know . . .

Oil Industry Information Committee

gives N. L. G. I.

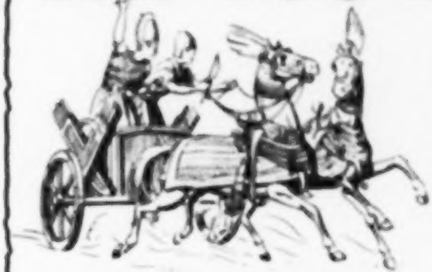
Outstanding Recognition

The drawing you see on the opposite page is one of two full pages currently appearing in the recent issue of Progress Pointers.

HELP THE O.I.I.C. BOOST YOUR INDUSTRY—

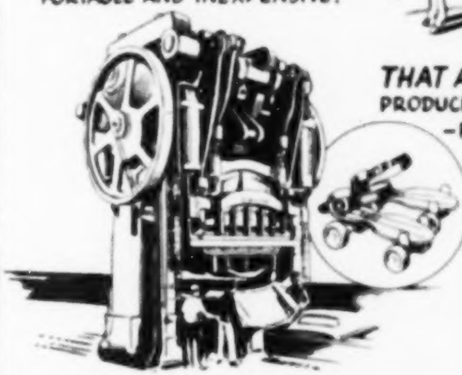
Reproduce this illustration in your own publication ! ! !

DID YOU KNOW —



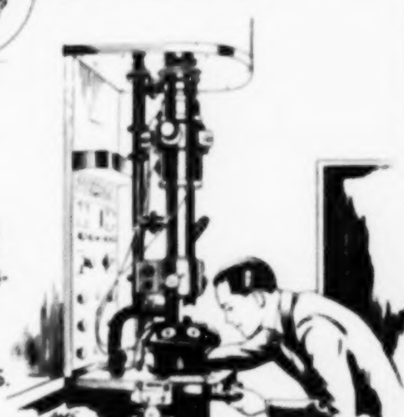
THAT GREASE WAS USED FOR LUBRICATING LONG BEFORE THE DISCOVERY OF OIL IN AMERICA? THE ANCIENT EGYPTIANS SMEARED ANIMAL FAT ON THE AXLES OF THEIR CHARIOTS FOR LUBRICATION. MODERN REFINING PRODUCES HIGH QUALITY LUBRICANTS FOR THOUSANDS OF VARIED USES.

THAT THE FIRST TAXI, HORSE-DRAWN AND COMPLETE WITH MILEAGE METER, WAS INVENTED IN THE EARLY 1500's BY LEONARDO DA VINCI ? TODAY, THOUSANDS OF OIL-POWERED AND OIL-LUBRICATED TAXIS HELP MAKE TRAVEL SWIFT, COMFORTABLE AND INEXPENSIVE.



THAT AMERICAN OIL COMPANIES PRODUCE MORE THAN 1500 LUBRICANTS —RANGING FROM GREASES FOR BIG INDUSTRIAL PLANTS TO LIGHT OILS FOR SUCH SIMPLE THINGS AS ROLLER SKATES.

THAT OIL RESEARCHERS USE AN ELECTRONIC MICROSCOPE WHICH PHOTOGRAPHS GREASE FIBRES MEASURING 29.37 MILLIONTHS OF AN INCH? THIS INSTRUMENT, WHICH MAGNIFIES UP TO 26,000 TIMES, IS ONLY ONE OF THE SCIENTIFIC TOOLS WHICH OIL MEN USE TO IMPROVE PRESENT PRODUCTS AND TO CREATE NEW ONES.



NEW

MOREHOUSE

SPEEDLINE MILL

Model B 1405

Specially designed for

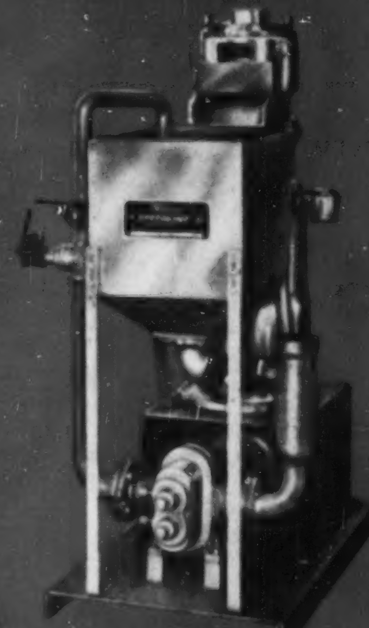
LUBRICANTS and COMPOUNDS

8,000 lbs. per hr. Milled and deaerated

Now there's a Morehouse Mill for the grease manufacturing business that doubles the production of ordinary equipment — in a fraction of the space, at a fraction of the cost! It is based on the same principle that for years has made Morehouse Mills the standard for big volume production in paint and similar fields.

Thoroughly proved in actual plant operations, this mill is setting new production records on a wide variety of greases, including metallic-soap base and other new solid additive types. Production rates up to 8,000 lbs. per hr. have been reported. It's setting new standards of quality, too, producing lubricants with appearances and textures that will amaze you.

This revolutionary mill is compact and versatile. It can be adjusted quickly and accurately. It can be easily transported by lift truck for use anywhere in your plant. It is easy to clean and all parts are easy to get at and are interchangeable. Last but not least, Morehouse Mills are low in original cost and economical to operate and maintain. Don't overlook this important development for manufacturing lubricants and compounds. Write for full details today!



Grease Mill
Model B 1405 with deaerator
SAVES SPACE
Height — 73½"
Length — 48"
Width — 30"

Morehouse Mills are
AVAILABLE FOR
TEST IN YOUR PLANT
Write for details

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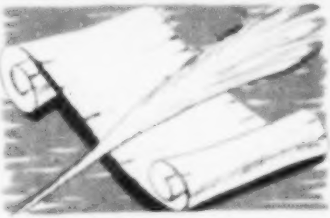

Supporting Your Organization These Suppliers of Your Industry Hold Membership in the N. L. G. I.

SUPPLIERS OF MATERIALS FOR MANUFACTURING LUBRICATING GREASES

Armour & Co., Chemical Division
1355 West 31st St.
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Member—Dale V. Stingley

American Cyanamid Company
30 Rockefeller Plaza
New York City, New York
Member—A. Scharwachter

Darling & Company
4201 South Ashland Avenue
Chicago 9, Illinois
Member—George W. Trainor

E. I. du Pont de Nemours & Company
Wilmington, Delaware
Member—J. R. Sabina

Emery Industries, Inc.
Carew Tower
Cincinnati 2, Ohio
Member—R. F. Brown

Foote Mineral Company
18 W. Chelten Street
Philadelphia 44, Pennsylvania
Member—H. C. Meyer, Jr.

A. Gross & Company
295 Madison Avenue
New York City 17, New York
Member—Eugene Adams

W. C. Hardesty Co., Inc.
41 East 42nd Street
New York City, New York
Member W. G. McLeod

Harshaw Chemical Company
1945 East 97th Street
Cleveland 6, Ohio
Member—G. G. Unkefer

Leffingwell Chemical Company
P. O. Box 191
Whittier, California
Member—D. E. Murphy

Lubrizol Corporation
Euclid Station
Cleveland 17, Ohio
Member—J. H. Baird

Mallinckrodt Chemical Works
New York 8, New York
St. Louis 7, Missouri
Member—C. E. Cosby

N. I. Malmstrom & Company
147 Lombardy Street
Brooklyn 22, New York
Member—Ivar Wm. Malmstrom

Metasap Chemical Corporation
Harrison, New Jersey
Member—O. E. Lohrke

Monsanto Chemical Company
1700 Second Street
St. Louis 4, Missouri
Member—J. W. Newcombe

National Lead Company
105 York Street
Brooklyn 1, New York
Member—Alexander Stewart

National Rosin Oil Products, Inc.
R.K.O. Bldg., Rockefeller Center
New York City, New York
Member—Richard Bender

M. W. Parsons, Imports & Plymouth Organic Labs., Inc.
59 Beekman Street
New York City 7, New York
Member—H. Bye

Swift & Company, Industrial Oil Division
165th & Indianapolis Blvd.
Hammond, Ind.
Member—F. H. Beneker

Warwick Chemical Company
Division of the Sun Chemical Corporation
10-10 44th Avenue
Long Island City 1, New York
Member—Dr. J. J. Whitfield

The Werner G. Smith Co.
(Division of Archer-Daniels-Midland Co.)
2191 West 110th Street
Cleveland 2, Ohio
Member—F. C. Haas

Witco Chemical Co.
75 E. Wacker Drive
Chicago, Illinois
Member—R. W. Lewis

CONTAINER MANUFACTURERS

Central Can Company, Inc.
2415 West 19th Street
Chicago, Illinois
Member—Henry Frazin

Continental Can Co.
1103 Waldheim Building
Kansas City 6, Missouri
Member—T. A. Graham

Geuder, Paeschke & Frey Co.
324 North Fifteenth Street
Milwaukee 3, Wisconsin
Member—Willard J. Flint

Inland Steel Container Company
6532 South Menard Avenue
Chicago 38, Illinois
Member—G. D. Zuck

J & L Steel Barrel Company
405 Lexington Ave.
New York 17, New York
Member—Jerry Lyons

National Steel Container Corporation
6700 South LeClaire Avenue
Chicago 38, Illinois
Member—Henry Rudy

Ohio Corrugating Co.
917 Roanoke Ave. So. E.
Warren, Ohio
Member—L. F. McKay

Rheem Manufacturing Company
570 Lexington Avenue
New York, New York
Member—G. Wesley Gates

United States Steel Products Co.
30 Rockefeller Plaza
New York City 20, New York
Member—Wm. I. Hanrahan

Vulcan Stamping & Manufacturing Co.
300 Madison Street
Bellwood, Illinois
Member—Dale M. Harpold

MANUFACTURERS OF EQUIPMENT FOR APPLICATION OF LUBRICATING GREASES

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Bryan, Ohio
Member—R. W. Morrison

Balcrank, Inc.
Disney near Marburg
Cincinnati 9, Ohio
Member—R. P. Field

Gray Company, Inc.
60 11th Avenue Northeast
Minneapolis 13, Minnesota
Member—L. L. Gray

Lincoln Engineering Company
5730 Natural Bridge Avenue
St. Louis, Missouri
Member—Foster Holmes

Morehouse Industries
1156 San Fernando Road
Los Angeles 65, California
Member—George E. Missbach

National Sales, Inc.
812 North Main Street
Wichita, Kansas
Member—Howard Dearmore

Stewart-Warner Corp.
1826-1852 Diversey Parkway
Chicago, Illinois
Member—Walter Duncan

U. S. Air Compressor Company
5300 Harvard
Cleveland, Ohio
Member—C. A. Bening

LABORATORY EQUIPMENT AND SUPPLIES

Precision Scientific Company
3737 Cortland Street
Chicago 47, Illinois
Member—Alexander I. Newman

SUPPLIERS OF EQUIPMENT FOR MANUFACTURING LUBRICATING GREASES

Buflovak Equipment Division of Blaw-Knox Company
1543 Fillmore Avenue
Buffalo 11, New York
Member—A. W. Johnson

The Girdler Corp.
Louisville 1, Kentucky
Member—John E. Slaughter, Jr.

Stratford Engineering Corporation
1414 Dierks Building
Kansas City, Missouri
Member—J. A. Altshuler

Synthetic Products Company
1636 Wayside
Cleveland, Ohio
Member—G. B. Curtiss

REFINERS

Calumet Refining Company
4323 Southwestern Blvd.
Chicago, Illinois
Member—H. E. Semerau

Farmers Union Central Exchange, Inc.
P. O. Box G
St. Paul 1, Minnesota
Member—H. F. Wagner

Mid-Continent Petroleum Corporation
Tulsa, Oklahoma
Member—T. E. Fitzgerald

TECHNICAL AND RESEARCH ORGANIZATIONS

Cargill, Incorporated
200 Grain Exchange
Minneapolis 15, Minnesota
Member—Dr. Sabine Hirsch

Mellon Institute of Industrial Research
University of Pittsburgh
Pittsburgh 13, Pennsylvania
Member—Malcolm Finlayson

Midwest Research Institute
4049 Pennsylvania
Kansas City 2, Missouri
Member—Dr. Geo. E. Ziegler